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Indian Standard

RECOMMENDED PRACTICE FOR ACOUSTIC EMISSION INSPECTION DURING HYDROSTATIC PRESSURE TESTING OF SYSTEM

ICS 17.140.99; 19.100

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Non-Destructive Testing Sectional Committee, MTD 21

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by Non-Destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Acoustic Emission (AE) testing is of specific importance towards non-destructive testing of systems hydrostatically pressurized, such as pressure vessels and piping system.

The basic functions of an acoustic emission monitoring system are to detect, locate and classify emission sources. Other methods of NDT may be used to further evaluate the significance of acoustic emission sources.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RECOMMENDED PRACTICE FOR ACOUSTIC EMISSION INSPECTION DURING HYDROSTATIC PRESSURE TESTING OF SYSTEM

1 SCOPE

This recommended practice guidelines for acoustic emission (AE) testing of systems, such as pressure vessels, piping systems or other structures during hydrostatic pressure testing of the system.

2 PRINCIPLE

When a system is pressurized hydrostatically, the pressurization produces changes in stresses in the structure.

During pressurization of a structure, AE is produced due to such source as (a) deformation, (b) initiation and propagation of cracks, (c) reshuffling of stress pattern at the region of high stress as (1) fluid leak, (2) loose part motion, and (3) relative movement between different parts of a structure. These AE signals can be detected by an instrumentation system using sensors which being normally of the piezoelectric type transform the mechanical excitation stimulated by stress wave, into electrical signals.

In addition to immediate evaluation of the emissions detected during the application of hydrostatic pressure a permanent record of the number and location of emitting sources and the relative amount of acoustic emission detected from each source provides a basis for comparison with sources detected during the test and during subsequent pressurization.

3 PERSONNEL QUALIFICATION

The acoustic emission inspection shall be performed by qualified personnel.

4 PREPARATION FOR INSPECTION

It shall be carried out as follows:

a) Areas which bend specific monitoring such as repaired regions, nozzles identified high stress areas etc, should be specified.

b) The type of sensors and their frequency ranges should be identified. Both sensor and couplant must be compatible with the surface conditions and the structural material to ensure the signal to noise ratio.

c) The maximum pressure that the vessel can be subjected to should also be specified.

d) The pressurization schedule should be specified. The pressurization schedule shall include holding time at each pressure level in terms of percent of maximum pressure and pressure should be continuously recorded.

e) There shall be proper communication between acoustic emission test control centre and pressurization control point.

f) All potential sources of extraneous acoustic noise such as mechanical vibrations, friction, and fluid flow should be identified. These sources should be isolated and minimized.

g) Acoustic emission monitoring system should be identified. Calibration should at least be done before and after the test. Additional calibration checks may be performed during the test if so required.

5 CALIBRATION OF EQUIPMENT

5.1 The sensitivity and locational accuracy of the Acoustic Emission monitoring system shall be determined by using the acoustic emission simulator.

5.2 Sensitivity Calibration shall be carried out as follows.

5.2.1 In order to set the gain for each sensor channel, locate the acoustic emission simulator at a selected distance from each sensor in turn. Monitor a sensor's response to the simulated emission and adjust the channel again to a specified amplitude level. Repeat this procedure for each acoustic emission sensor on the structure and adjust the amplified outputs, corresponding to the identical simulations of each to the specified peak voltage, within ±1 dB.

5.3 Accuracy of source location shall be determined as follows.

5.3.1 Check the operation of the acoustic emission source location function by analyzing simulated acoustic emission signals from several random locations on the structure as well as from any specific critical locations. For each placement of the simulator, determine and record the precision and accuracy of the acoustic emission location function.

6 INSPECTION PROCEDURE

6.1 Acoustic emission data shall be accumulated during and if only after pressurization, then how to plot the data as suggested in Fig. 1 after pressurization of the system or both.

6.1.1 During application of hydrostatic pressure the locations of acoustic sources are usually determined through analysis of the difference in time of arrival of Acoustic Emission signals at acoustic sensors. Such analysis may be performed through the use of an analog or digital computer. The computer accumulates and analyses data over a specified pressure range. As the pressure is applied record the number and location of emitting source and the amount of acoustic emission detected from each source. The acoustic emission activity at one or more sensors may be monitored and displayed in real time during pressurization. If the acoustic emission count rate in the form of acoustic emission, count rate, event rate, energy or a similar acoustic emission quantity shows an appreciable increase notify the owner of the structure or his representative immediately. It shall be his decision to reduce, hold or stop the test. The cause of acoustic emission increase shall be investigated before continuing the test.

6.1.2 Calibration shall be repeated after the test and changes recorded in gain setting and source location performance. Appropriate compensation shall be made during data interpretation.

7 INTERPRETATION OF RESULTS

7.1 All results shall be summarized on an appropriate layout map, displayed or tabulated or both for ready reference and interpretation. This layout or tabulation shall display the location and classification of each source with pertinent comments.

7.2 Source Location

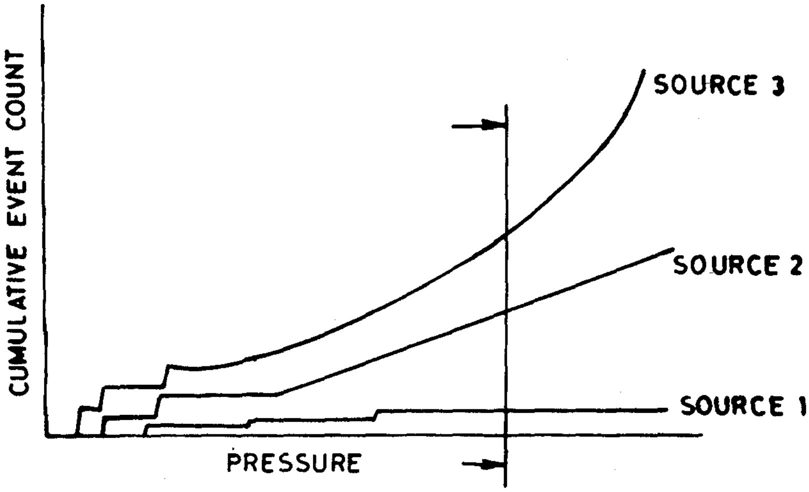
All locations data resulting from analysis shall be presented in a manner consistent with the previously established calibration accuracy.

7.3 Source Classification

Sources shall be classified with respect to their acoustic activity and intensity.

7.3.1 Activity of a source shall be measured by event count or emission count. Source is considered to be active if its event count or emission count continues to increase with increasing or constant stimulation. A source is considered to be critically active if the derivative of its event count or emission count with respect to stimulus continuously increases with increasing pressurization or with time under constant pressure (*see* Fig.1).

7.3.2 An intensity measure of a source is its average amplitude per event also, the emission count per event, the emission energy per event or other quantities that can be shown to be related to the amplitude of the signal, can be used as intensity measures. A source is considered to be intense if it is active and its intensity measure consistently exceeds, by a specified amount, the average intensity of active source. The intensity of a source can be calculated for increments of the stimulus or of events. An intense source is considered to be critically intense if its intensity continuously increase with increasing stimulation or with time under constant stimulus (*see* Fig. 2).



NOTE — To the right of the vertical line, Source 1 is inactive, Source 2 is active and Source 3 is critically active.

FIG. 1 SCHEMATIC REPRESENTATION OF THREE DIFFERENT TYPES

7.4 Evaluation of classified source shall be as given below:

a) Sources considered to be critically active or critically intense or both are indicative of questionable structural intensity and, if possible, shall be evaluated by other NDT methods.

b) Sources considered to be intense are indicative of possible flaw growth and, if possible should be evaluated by other NDT methods.

c) Sources considered to be active but not intense shall be recorded for comparison with sources detected during subsequent examination.

d) Sources considered to be of low activity and intensity are not usually required to be further evaluated for subsequent correlation.

8 REPORT

All calibration data and instrument adjustment including equipment description and performance data, shall be included in the records of the inspection and be signed by the inspecting authority. The information recorded shall be sufficient to permit complete re-analysis of the results. This information shall include the following:

a) Complete identification of vessel, material, method of fabrication, manufacturer's name, previous history and maintenance as well as its maximum operating pressure prior to AE inspection;

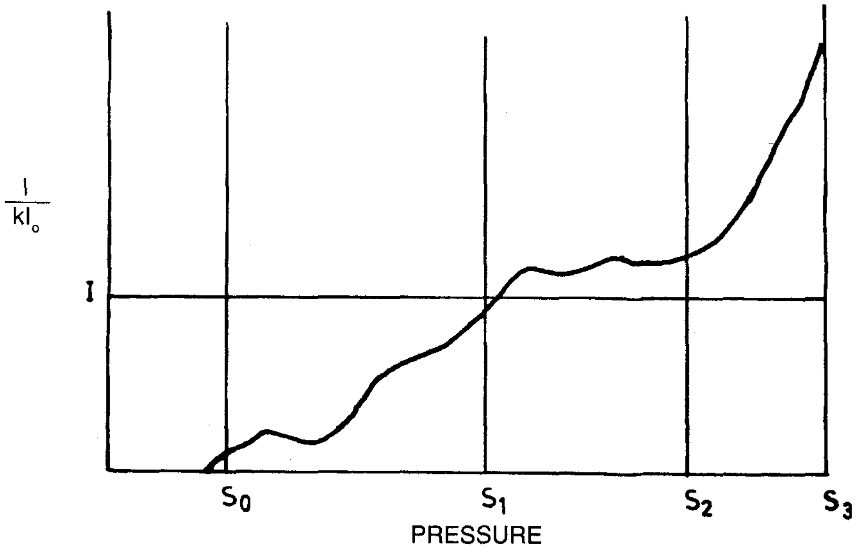
b) Details of AE equipment, manufacturer;s name, Model No.;

c) Sensor specification, sensitivity, frequency, type of couplant;

d) Vessel sketch with number of sensors with their locations;

e) Inspector's name and his qualification; and

f) Suspect areas to be shown on a sketch of vessel along with data of AE signals and interpretation of results.



NOTE — Four different regions are shown prior to S_0, the source was inactive between S_0 and S_1, the source was of low intensity between S_1 and S_2, the source is classified as critically intense.

FIG. 2 SOURCE INTENSITY I DIVIDED BY A WEIGHTED AVERAGE INTENSITY OF ALL SOURCES, kI_0 PLOTTED AGAINST THE PRESSURE

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices:		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	323 76 17, 323 38 41
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola CALCUTTA 700054	337 84 99, 337 85 61 337 86 26, 337 91 20
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43 60 20 25
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
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